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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

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June 1970
U.S. Training and Employment Service
Technical Report
S-401R

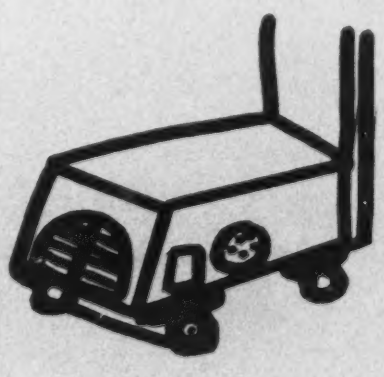
Development of USTES

APTITUDE TEST BATTERY FOR

HEAT TREATER
(heat treat.) I
504.782

HEAT TREATER
(heat treat.) II
504.782

U.S. DEPARTMENT OF LABOR
Manpower Administration



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Technical Report on Development of USTES Aptitude Test Batteries

For . . .

Heat Treater (heat treat.) I 504.782-026

Heat Treater (heat treat.) II 504.782-030

S-401 R

(Developed in Cooperation with the
California, Michigan, Ohio, Pennsylvania and
Texas State Employment Services)

U. S. Department of Labor
Manpower Administration

June 1970

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB 2656

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

For

HEAT TREATER (heat treat.) I 504.782-026
HEAT TREATER (heat treat.) II 504.782-030
S-401 R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Heat Treater. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
P-Form Perception	80
Q-Clerical Perception	90
M-Manual Dexterity	70

RESEARCH SUMMARY

Sample

78 male workers employed as Heat Treaters.
This study was conducted prior to the requirement of providing minority group information. Therefore, minority group status is unknown.

Criterion

Supervisory ratings

Design

Concurrent (test and criterion data were collected at approximately the same time)

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Concurrent Validity

Phi Coefficient = .37 (P/2 less than .0005)

Effectiveness of Norms

Only 64% of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the above norms, 81% would have been good workers. Thirty-six percent of the non-test-selected workers used for this study were poor workers; if the workers had been test-selected with the above norms, only 19% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1:

TABLE I

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	64%	81%
Poor Workers	36%	19%

SAMPLE DESCRIPTION

Size

N = 78

Occupational Status

Employed workers

Work Setting

Metlab Company	Philadelphia, Penna.
Pittsburgh Commercial Heat & Treating Co.	Pittsburgh, Penna.
Metal Treating Company	Pittsburgh, Penna.
Vac-Hyd Processing Corporation	Torrance, California
National Heat Treating Company	Inglewood and Anaheim, California
Downey Heat Treating Company, Inc.	Downey and Anaheim, California
Dominy Heat Treating Company	Dallas, Texas
Houston Heat Treating Company	Houston, Texas
Lone Star Heat Treating Corporation	Houston, Texas
Perzy Heat Treat Inc.	Grand Prairie, Texas
Superior Heat Treating Company	Fort Worth, Texas
United Heat Treating Company	Fort Worth, Texas
Commonwealth Industries Inc.	Detroit, Michigan
Dayton Forging and Heat Treating Company	Dayton, Ohio
Commerical Industrial and Heat Treating Co.	Ohio

Employer Selection Requirements

Education: None except Pittsburgh Commercial Heat Treating Company requires high school or vocational school graduation.

Previous Experience: None

Tests: The Metlab Company gives the Wonderlic and Bennett Mechanical Comprehensive Test but does not use these tests to determine selection; the Commonwealth Industries Inc. sample was pre-screened with the Wonderlic Personnel Test.

Other: Personal interview for all employers, physical exams for some employers.

Principal Activities:

The job duties of each worker are comparable to those shown in the job description in the Appendix.

Minimum Experience:

All workers had at least two months total job experience.

TABLE 2

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Experience

	Mean	SD	Range	r
Age (years)	37.6	10.9	19 - 60	-.134
Education (years)	10.5	2.3	6 - 17	.180
Experience (months)	122.2	93.0	2 - 355	-.048

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B, were administered during the period from May 1966 to February 1967.

CRITERION

The criterion data consisted of supervisory ratings of job proficiency made at approximately the same time as test data were collected.

Rating Scale:

Form SP-21 "Descriptive Rating Scale." This scale consists of nine items covering different aspects of job performance. Each item has five alternatives corresponding to different degrees of job proficiency. A copy of this form is shown in the Appendix.

Reliability:

Since only 56 second ratings were obtained, an estimate of reliability between the two ratings was made. The correlation of .91 indicated satisfactory reliability. The final criterion consisted of the first ratings.

Criterion Score Distribution:

Possible Range: 9 - 45
Actual Range: 15 - 44
Mean: 31.4
Standard Deviation: 7.2

Criterion Dichotomy:

The criterion distribution was dichotomized into low and high groups by placing 36% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high group were designated as "good workers" and those in the low group as "poor workers." The criterion critical score is 29.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were considered for inclusion in the norms on the basis of a qualitative analysis of job duties involved and a statistical analyses of test and criterion data. Aptitude M, which does not have a significant correlation with the criterion was considered for inclusion in the norms because the qualitative analysis indicated that it was important for the job duties and the sample had a relatively high mean score on this aptitude. With employed workers, a relatively high mean score may mean that some sample pre-selection has taken place. Tables 3, 4 and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G-General Learning Ability	Makes decisions concerning proper methods and techniques to use in heat treating a variety of metals
P-Form Perception	Inspects process work to determine if it is acceptable
Q-Clerical Perception	Studies work order to ascertain processing instructions
M-Manual Dexterity	Turns dials and valves to control operations

TABLE 4

Means, Standard Deviations (SD) and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

	Mean	SD	Range	r
G - General Learning Ability	87.5	20.8	49-149	.274*
V - Verbal Aptitude	89.0	17.3	63-143	.209
N - Numerical Aptitude	81.8	24.4	36-149	.215
S - Spatial Aptitude	93.4	20.6	55-130	.298**
P - Form Perception	90.5	22.7	38-137	.257*
Q - Clerical Perception	98.8	18.3	68-170	.328**
K - Motor Coordination	91.2	21.6	39-140	.197
F - Finger Dexterity	87.0	21.9	12-141	.289*
M - Manual Dexterity	100.3	24.0	15-164	.161

* Significant at the .05 level
** Significant at the .01 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X				X	X			X
Irrelevant		O							
Relatively High Mean				X		X			X
Relatively Low Standard Dev.									
Significant Correlation with Criterion	X			X	X	X		X	
Aptitudes to be Considered for Trial Norms	G			S	P	Q		F	M

DEVIATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of Aptitudes G, S, P, Q, F and M at trial cutting scores were able to differentiate between the 64% of the sample considered good workers and the 36% of the sample considered poor workers. Trial cutting scores at five point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly higher than one standard deviaton below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores of slightly lower than one standard deviation below the mean will eliminate about one-third of the sample. The phi coefficient was used as a basis for comparing trial norms. Norms of P-80, Q-90 and M-70 provided optimum differentiation for the occupation of Heat Treater. The validity of these norms is shown in Table 6 and is indicated by a phi coefficient of .37 (statistically significant at the .0005 level.)

TABLE 6

Concurrent Validity of Test Norms
P-80, Q-90, and M-70

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	15	35	50
Poor Workers	20	8	28
Total	35	43	78

Phi coefficient = .37 Chi Square (χ^2_4) = 10.8
Significance level = P/2 less than .0005

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study did not meet the requirements for incorporating the occupation studied into OAP-52 which is shown in the 1970 edition of Section II of the Manual for the General Aptitude Test Battery. A Phi Coefficient of .29 is obtained with the OAP-52 norms of P-80, Q-90, M-80.

SP-21
Rev. 2/61

A-P-P-E-N-D-I-X

DESCRIPTIVE RATING SCALE
(For Aptitude Test Development Studies)

Score____

RATING SCALE FOR _____
D. O. T. Title and Code

Directions: Please read Form SP-20, "Suggestions to Raters", and then fill in the items listed below. In making your ratings, only one box should be checked for each question.

Name of Worker (print) _____
(Last) (First)

Sex: Male____ Female____

Company Job Title: _____

How often do you see this worker in a work situation?

☐ See him at work all the time.

☐ See him at work several times a day.

☐ See him at work several times a week.

☐ Seldom see him in work situation.

How long have you worked with him?

☐ Under one month.

☐ One to two months.

☐ Three to five months.

☐ Six months or more.

A. How much work can he get done? (Worker's ability to make efficient use of his time and to work at high speed.)

☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.

☐ 2. Capable of low work output. Can perform at a slow pace.

☐ 3. Capable of fair work output. Can perform at an acceptable but not a fast pace.

☐ 4. Capable of high work output. Can perform at a fast pace.

☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of his work? (Worker's ability to do high-grade work which meets quality standards.)

☐ 1. Performance is inferior and almost never meets minimum quality standards.

☐ 2. The grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.

☐ 3. Performance is acceptable but usually not superior in quality.

☐ 4. Performance is usually superior in quality.

☐ 5. Performance is almost always of the highest quality.

C. How accurate is he in his work? (Worker's ability to avoid making mistakes.)

☐ 1. Makes very many mistakes. Work needs constant checking.

☐ 2. Makes frequent mistakes. Work needs more checking than is desirable.

☐ 3. Makes mistakes occasionally. Work needs only normal checking.

☐ 4. Makes few mistakes. Work seldom needs checking.

☐ 5. Rarely makes a mistake. Work almost never needs checking.

D. How much does he know about his job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

☐ 1. Has very limited knowledge. Does not know enough to do his job adequately.

☐ 2. Has little knowledge. Knows enough to "get by."

☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.

☐ 4. Has broad knowledge. Knows enough to do good work.

☐ 5. Has complete knowledge. Knows his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

☐ 1. Has great difficulty doing his job. Not at all suited to this kind of work.

☐ 2. Usually has some difficulty doing his job. Not too well suited to this kind of work.

☐ 3. Does his job without too much difficulty. Fairly well suited to this kind of work.

☐ 4. Usually does his job without difficulty. Well suited to this kind of work.

☐ 5. Does his job with great ease. Exceptionally well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

☐ 1. Cannot perform different operations adequately.

☐ 2. Can perform a limited number of different operations efficiently.

☐ 3. Can perform several different operations with reasonable efficiency.

☐ 4. Can perform many different operations efficiently.

☐ 5. Can perform an unusually large variety of different operations efficiently.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

☐ 1. Almost never is able to figure out what to do. Needs help on even minor problems.

☐ 2. Often has difficulty handling new situations. Needs help on all but simple problems.

☐ 3. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.

☐ 4. Usually able to handle new situations. Needs help on only complex problems.

☐ 5. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How many practical suggestions does he make for doing things in better ways? (Worker's ability to improve work methods.)

☐ 1. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.

☐ 2. Slow to see new ways to improve methods. Contributes few practical suggestions.

☐ 3. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.

☐ 4. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.

☐ 5. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and <u>only</u> these factors, how acceptable is his work? (Worker's "all-around" ability to do his job.)

☐ 1. Would be better off without him. Performance usually not acceptable.

☐ 2. Of limited value to the organization. Performance somewhat inferior.

☐ 3. A fairly proficient worker. Performance generally acceptable.

☐ 4. A valuable worker. Performance usually superior.

☐ 5. An unusually competent worker. Performance almost always top notch.

FACT SHEET

Job Titles

Heat Treater (heat treat.) I 504.782-026
Heat Treater (heat treat.) II 504.782-030

Job Summary - Heat Treater I

Alters physical and chemical properties of metal objects, determining heating and cooling processes to harden, anneal, caseharden or normalize the metal.

Work Performed - Heat Treater I

1. Determines heating and cooling process: Receives job process and quality control card from supervisor and using it as guide determines heating and cooling processes required to treat metal. Selects proper furnace and quenching equipment to use in order to comply with specifications and job processes set forth on control card. Uses heat-treating charts, knowledge of heat-treating methods and equipment and properties of metal to determine temperature, time of heating cycle and type and temperature of quenching medium.
2. Places parts in furnace: Loads parts or metal objects into furnace using tongs, grappling hooks or overhead hoist or places parts on racks, trays or in baskets using conveyor to move them into furnace.
3. Adjusts furnace temperature: Lights furnace and regulates heat by adjusting control valves or switches to bring furnace to required temperature and to control the amount of fuel and compressed air injected into furnace. Observes pyrometer (heat indicator and controller) to determine that furnace is operating at required temperature level.
4. Removes from furnace: Lifts parts or metal object from furnace using tongs or grappling hooks of various sizes and shapes after specified temperature has been reached as indicated on pyrometer. Large parts are handled with assistance of other workers or by using overhead hoist. Parts are transferred to quenching media automatically in automatic furnaces.
5. Regulates quenching equipment: Maintains quenching baths at specified temperatures by turning fuel control valves or regulating rate of circulating liquid through cooling system.
6. Quenches parts: Submerges parts in quenching media such as oil, water or brine by using tongs or grappling hooks of various sizes and shapes depending on type of objects handled. Lifts parts from quenching liquid after specified cooling time using tongs and grappling hooks. Carries parts to area in shop where they will be cleaned, checked for flaws or tested for hardness as required.
7. Examines parts for conformity: Inspects processed parts visually and with magnaflux equipment to assure conformity to specifications. Tests metal objects to determine degree of hardness using Brinnell or Rockwell testing devices.
8. Repairs pyrometers, furnaces, quenching tanks and related equipment used in heat treating process.

9. Posts work performed on job control card: Fills in job process and quality control card for all operations performed in the heat treating process, describing the work done, recording time required to do work and any changes made in heat treating operations.

Job Summary - Heat Treater II

Alters physical and chemical properties of metal objects to impart desired tensile strength, following specified heating and cooling processes.

Work Performed - Heat Treater II

Sets up furnace and metal object to be processed. Reads work order to ascertain type of furnace, temperature cycles, type and temperature of quench and type of hardness test to employ. Determines type of work holding fixture, jig or basket needed for positioning by studying size and shape of object or consults with foreman. Attaches hooks or chain to object and overhead crane. Operates overhead crane by pressing control panel buttons by hand to position object in fixture, jig or basket. Positions small objects in basket manually; positions object in basket frequently by wiring to enable even heat distribution. Presses switch to start and control conveyor or hoist to transfer basket of objects or individual object to furnace for processing.

Controls heating and cooling of metal objects to change physical properties. Turns knobs to set gauges and timer to control temperature and exposure time in the furnace. Observes gauges and turns valves to regulate flow of carbon into furnace as required by hardness specifications. Quenches heated parts in oil, air or water as specified to control hardness. Repeats heating and cooling cycle as required.

Removes objects from furnace and controls warping. Presses switch to start, stop and control conveyor or hoist to remove basket or individual objects from furnace. Requests inspector to test processed objects to determine if they meet stated specifications. Reprocesses objects to bring hardness within designated tolerances by altering heating or cooling cycle. Arranges objects in one of a variety of tension devices to prevent warping during the cooling stage.

Fills in job process and quality control card completely and accurately for all operations performed describing the work done, recording the time required to do the work and noting changes made in heat treating operations.

Effectiveness of Norms

Only 64% of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the S-401Rnorms, 81% would have been good workers. Thirty-six percent of the non-test-selected workers used for this study were poor workers; if the workers had been test-selected with the S-401Rnorms, only 19% would have been poor workers.

Applicability of S-401RNorms

The aptitude test battery is applicable to jobs which include a majority of duties described above.

GPO 898-817

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